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CHANGES IN FOREST CONDITIONS 1936-1949 NORTH CENTRAL MINNESOTA AND UPPER PENINSULA OF MICHIGAN

(A PRELIMINARY ANALYSIS)

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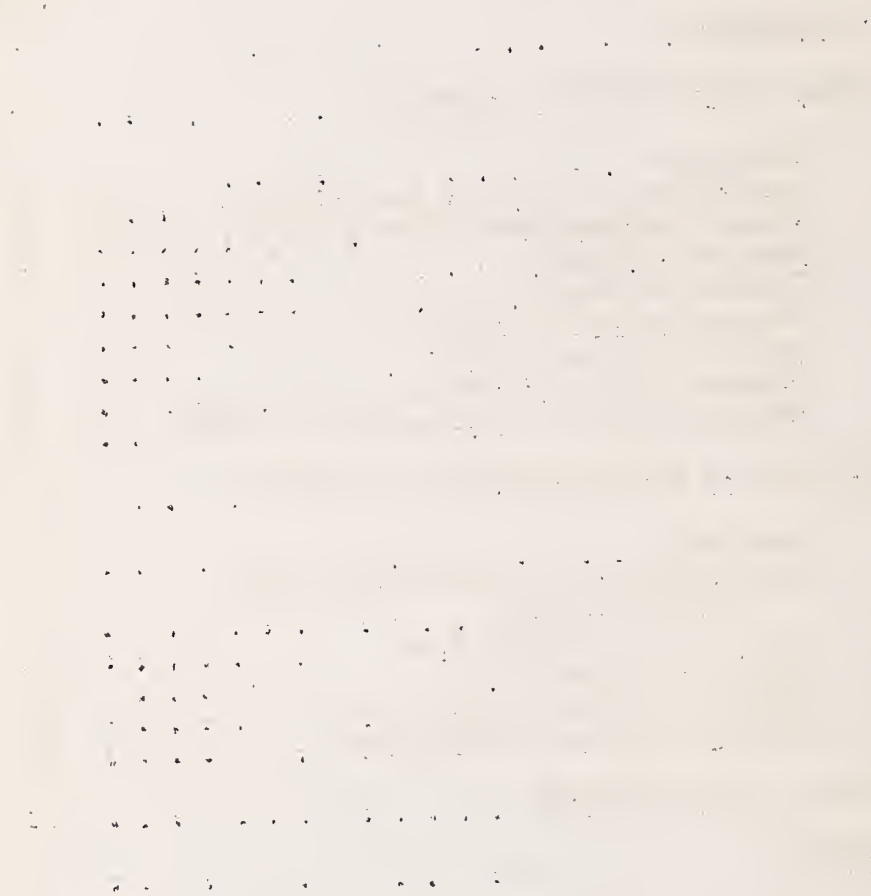

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NORTH CENTRAL MINNESOTA AND UPPER PENINSULA OF MICHIGAN
(A PRELIMINARY ANALYSIS)

By R. N. Cunningham, Forest Economist

INTRODUCTION

What has happened to the forests of the Lake States as a result of the abnormally heavy cutting during and since World War II and also from the stimulus of improved fire protection and other measures of forest management? This is a question of great interest to many foresters, conservationists, and others concerned with the timber resource.

In Michigan and Minnesota the current Forest Survey has progressed sufficiently far to offer a basis for preliminary appraisal in two districts: The central pine district of Minnesota and the west half of the Upper Peninsula of Michigan. Here are available the results of a field survey completed late in 1935 and also tabulations for most of the counties and fractional tracts making up the districts, from resurveys made between 1947 and 1951.2/ The elapsed time between surveys was roughly 13 years as an average.

There are several differences in the way the two surveys were made (see page 20 in Appendix), but it is believed that the figures convey information of real significance and should help to give an understanding of forestry trends which may be under way. It must be borne in mind, of course, that the two districts are not necessarily representative of the region as a whole.

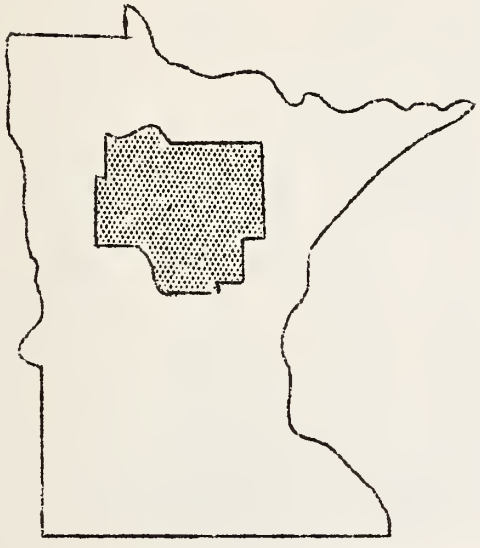
1/ Maintained by the U. S. Department of Agriculture, Forest Service, in cooperation with the University of Minnesota at University Farm, St. Paul, Minnesota.

2/ The author is indebted to Clarence Chase and others of the Survey group at the Lake States Station for compilation of recent data for the Upper Peninsula of Michigan; also to Lynn Sandberg, J. Marvin Kittelson, and others of the Iron Range Resources group for preliminary Minnesota survey figures.

CENTRAL PINE DISTRICT - MINNESOTA

Background

Location of District



The district has a gross land area of 7,206,000 acres, of which 5,285,000 acres (73 percent) were classified as forest in 1936. For comparability, the same total acreage is maintained in this analysis.3/

The original forest here was primarily pine, running out to prairie on the west and into spruce bogs on the north. Poor hardwoods, maple-basswood, oak, and ash-elm occurred spottily in the north and more or less continually around the southern margin.

Currently the major types are aspen, jack pine, swamp conifers (black spruce, tamarack, white cedar), northern hardwoods, ash-elm, and scrubby oak. Valuable old-growth is confined mainly to public preserves and scattered groves in various ownerships.

The district contains one national forest, portions of two major Indian Reservations, 16 state forests or parks, and a number of recently organized county forests.

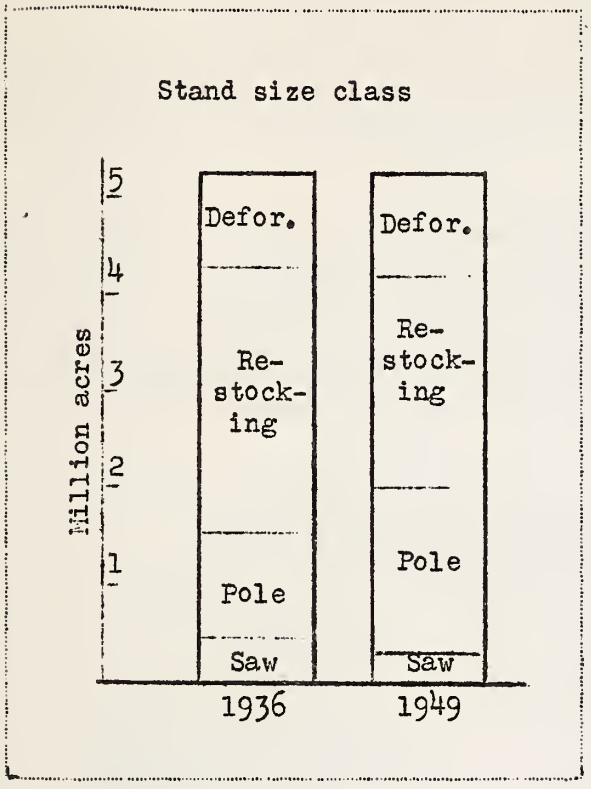
The district supports two pulp mills and several hundred smaller industries, and in addition exports quantities of wood to other parts of Minnesota and to Wisconsin.

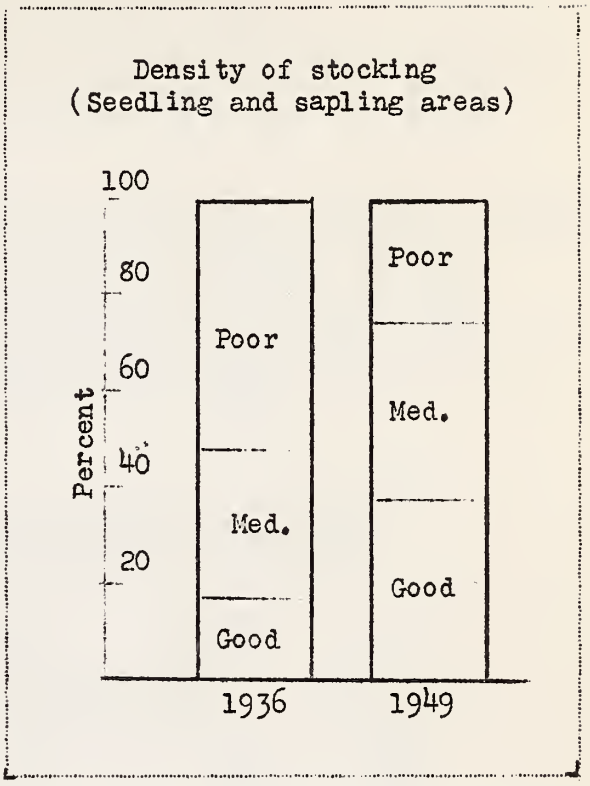
The first survey was made during the depression when timber industries were relatively inactive. Cutting for lumber and pulp began to accelerate in 1937 and was boosted in 1939-40 by demand for grain bins. During the war, cutting was very heavy and since 1946 has continued strong in most areas.

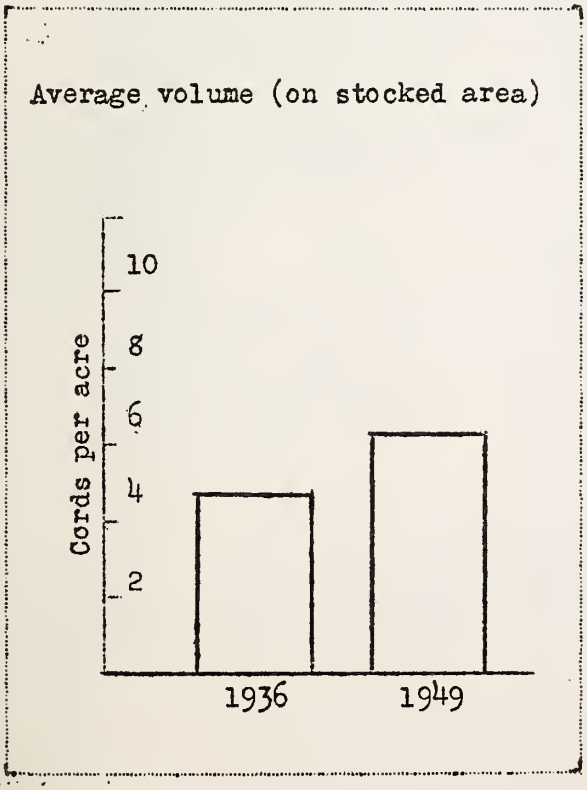
The district has a thriving tourist industry based upon forests and waters. It has some watershed significance in that it surrounds the headwaters of the Mississippi River and supplies water for urban consumption, for power, for navigation, and for limited irrigation.

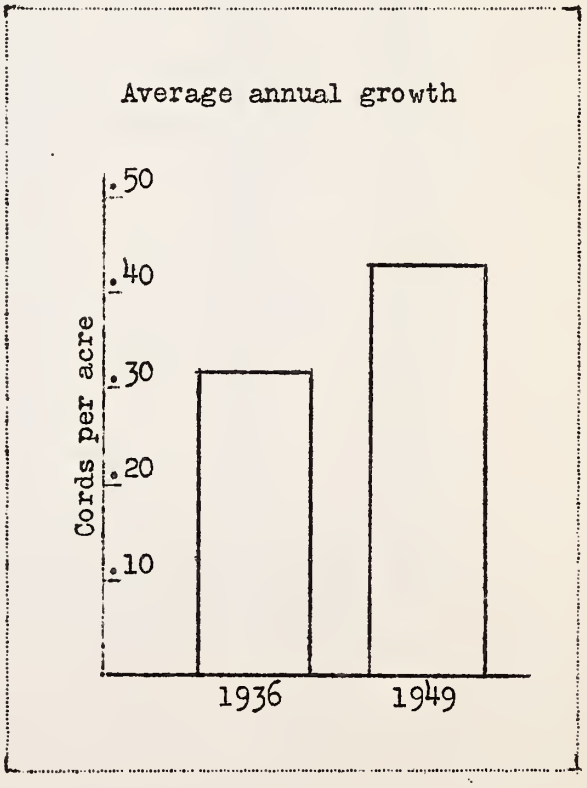
3/ New survey reports include more deforested swamp land in the commercial forest category than the original survey did. To facilitate comparisons, the excess has been eliminated arbitrarily.

Outstanding changes in Forest Conditions, 1936-1949
Central Pine District of Minnesota









Type Changes in Central Pine District

Softwood types declined nearly 10 percent in area between the 1936 and 1949 surveys (table 1). Percentagewise, the greatest loss was in the spruce-balsam and the white and red pine types. Grass, brush, and the ash-elm (lowland hardwood) types increased.

Other than the gain in ash-elm, which could be explained by removal of white pine, spruce, and balsam trees, from mixed stands formerly classified as softwood types, the changes in hardwood acreage are not striking. No doubt changes have occurred but they have been compensating. Some grass and brushland has restocked during the period but on the other hand, large areas of forest have been denuded. Some aspen has evolved into other types but nearly as much former brushland has restocked with aspen.

Table 1.- Comparison of forest type acreages shown by two forest surveys - Central Pine District, Minnesota

Forest type	Original survey	Current resurvey	Change
	Thousand acres		Percent
White and red pine	152	123	-19
Jack pine	481	465	- 3
Spruce-balsam fir	244	189	-23
Swamp conifer	465	438	- 6
All softwood	1,342	1,215	- 9½
Northern hardwood	302	308	+ 2
Ash-elm	199	296	+49
Oak	161	165	+ 2½
Aspen	2,314	2,254	- 2½
All hardwood	2,976	3,023	+ 1½
Grass and brush	891	1/ 1,010	+13
All commercial forest	5,209	5,248	+ 1
Nonproductive swamp	76	37	-51
TOTAL FOREST	5,285	5,285	0

1/ Excluding approximately 500,000 acres of grass and marsh land of a kind not considered forest land in the original survey but listed as potential forest land in recent county reports.

Changes in Stand-Size Class

The most notable changes between surveys were:

1. A drop of more than 50 percent in area of large saw timber occurring largely in the softwood types.

2. A decline of nearly 23 percent in small saw timber - less significant because some of the change in aspen is a matter of classification. (Old survey classified aspen as saw timber down to a 9.0 inches d.b.h., whereas current surveys cut off at 11.0 inches. As a result, few aspen stands now qualify as saw timber.)

3. An increase of more than 50 percent in pole timber area. Apparently large acreages of aspen and other hardwood saplings have graduated into pole-size during the interim.

4. A reduction in area of seedlings and saplings.

Table 2.- Stand-size class acreages in two surveys
Central Pine District, Minnesota

Forest types	Survey	Stand-size class				
		Saw timber		Pole timber	Seedlings and saplings	All classes 1/
		Large	Small			
		Thousand acres				
Pine	Old	47	92	250	244	633
	New	18	109	216	245	588
Other softwood	Old	7	52	248	402	709
	New	1	20	293	313	627
Aspen-birch	Old	4	132	491	1,687	2,314
	New	2	47	888	1,317	2,254
Other hardwood	Old	9	97	142	414	662
	New	10	112	356	291	769
All types	Old	67	373	1,131	2,747	4,318
	New	31	288	1,753	2,166	4,238

1/ Excluding deforested and non-commercial area.

Changes in Density

In both surveys, stands were classified as good, medium, or poor density under essentially the same standards. Comparison of figures (table 3) indicates a definite improvement over the period.

For pole stands, the improvement is consistent throughout, although in jack pine the change is not large presumably because of the heavy cutting to which it has been subjected. The over-all density of pole stands increased from 39 percent of full stocking[4/] on the old survey to 47 percent in the new.

On restocking areas, all types except white and red pine show improvement. Over-all density increased from 44 percent in the old survey to 59 percent in the new.

Table 3.- Comparison of stand density, 1936 and 1949, Central Pine District, Minnesota

Forest types	Stocking					
	Old survey			New survey		
	Good	Medium	Poor	Good	Medium	Poor
POLE STANDS						
	Percentage					
Pine	18	30	52	20	34	46
Other softwood	10	25	65	27	35	38
Aspen	11	25	64	18	38	44
Other hardwood	2	18	80	12	34	54
All types	11	26	63	19	36	45
RESTOCKING AREAS						
Pine	20	28	52	24	33	43
Other softwood	21	33	46	38	32	30
Aspen	17	32	51	44	37	19
Other hardwood	9	28	63	24	42	34
All types	17	31	52	38	37	25

4/ Using a weight of 85 percent for good stocking, 55 percent for medium, and 25 percent for poor.

Changes in Volume

The new survey has not progressed to the point where total volumes can be compared. In the first four counties reported, however, volumes per acre averaged generally higher than in the earlier survey, specifically:

	Average volume per acre*	
	Saw timber (Bd.ft., Int.)	Total volume (Cords)
Old survey	680	4.7
New survey		
Aitkin County	600	5.1
Crow Wing County	730	5.6
Clearwater County	630	7.0
Cass County	1,160	7.3
Four counties	840	6.3

* On productive forest land only, excluding deforested area and stagnant bogs.

The increase in volume per acre, insofar as the four counties are concerned, occurred consistently in all major types.

Changes in Rate of Growth

Growth estimates for the first four Minnesota counties covered in the new survey indicated substantial increase over the previous estimate for the district as a whole.

	Average annual growth per acre*	
	Saw timber (Bd.ft., Int.)	Total volume (Cords)
Old survey	35	.32
New survey		
Aitkin County	54	.46
Crow Wing County	75	.33
Clearwater County	71	.40
Cass County	81	.47
Four counties	71	.43

* Productive forest area only, excluding deforested land and stagnant bog.

Saw-timber growth increased in all major type groups. Growth in total cubic volume (recorded in cords) declined in the pine group but increased in all other groups.

Change in Allowable Cut

In the earlier survey it was estimated that the Central Pine District forests, with good management, could support an annual cut of 115,000 M board feet, or 39,400 M cubic feet. This is equivalent to 26,600 M board feet or 114,000 cords per million acres of productive forest area. Recent surveys indicate a larger possible cut as follows:

	Allowable annual cut per million acres of productive forest*	
	Saw timber (M bd.ft.,Int.)	Total volume (Cords)
Old survey	26,600	114,000
New survey		
Aitkin County	22,900	144,000
Crow Wing County	37,000	200,000
Clearwater County	43,100	357,000
Cass County	46,100	252,000
Four counties	37,000	228,000

* Noncommercial and deforested area excluded.

The increase in allowable cut is almost entirely in aspen and other hardwoods.

Changes in Rate of Cutting

Cutting drain on the original survey was expressed as the normal (pre-depression average) rate of cutting for mills and other wood users active at the time of the survey. This was substantially higher than actual rate of cutting in 1935.

Drain in recent years has been the estimated actual cut for specified years.

The recent rate of cutting, judging by data from the four counties, is less than previously reported in saw-timber material but greater in total cubic volume.

	Estimated annual drain per million acres productive forest land	
	Saw timber (M bd.ft.,Int.)	Total volume (Cords)
Old survey (Est. 1936-45)	26,800	140,000
New survey		
Aitkin County (1946)	21,600	118,000
Crow Wing County (1946)	26,500	251,000
Clearwater County (1946)	29,300	322,000
Cass County (1949)	16,800	139,000
Four counties	21,800	179,000

Changes in Drain vs. Allowable Cut Ratio

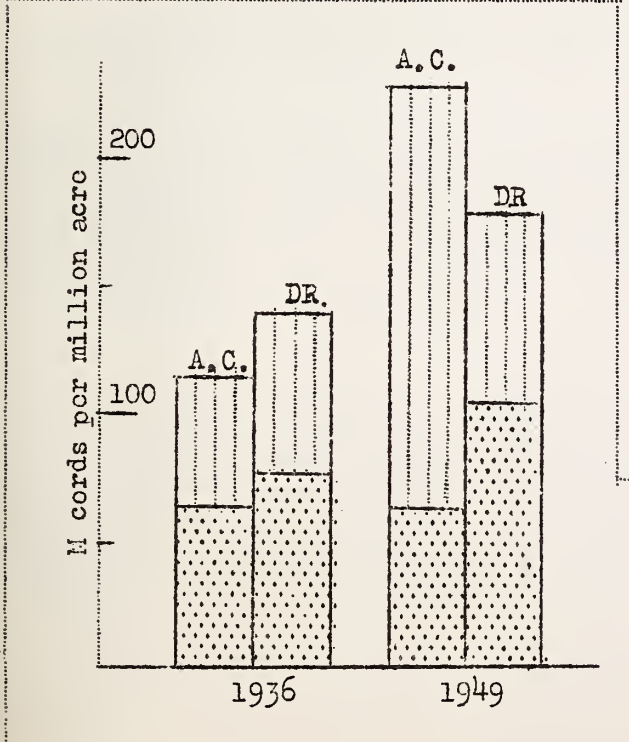
The first survey showed drain about equal to allowable cut in saw timber material, but about 23 percent greater than allowable cut in terms of total volume. No important difference was shown for softwoods and hardwoods.

The recent resurveys for four counties indicate that overall drain is but 59 percent of allowable cut in saw-timber material and 78 percent in total volume.

In both cases, the allowable cut was predicated on good cutting practices (including considerable thinning and improvement cutting in the more recent estimate); and also upon close utilization with the cut spread over both accessible and inaccessible areas. It exaggerates the cut permissible with practices now prevailing in the district.

	Drain as percentage of allowable cut	
	Old survey	New survey*
Saw timber		
Softwoods	97	80
Hardwoods	106	46
All species	101	59
Total volume		
Softwoods	122	164
Hardwoods	124	45
All species	123	78

* Based upon four counties: Aitkin, Crow Wing, Clearwater, and Cass.



The recent surveys indicate that over-all drain is conservative; but the drain on softwoods is excessive, while hardwoods are not being used in large enough quantities.

Records for individual counties show drain-allowable cut ratios more favorable in some than others. Also they usually show over-cutting on private lands, under-cutting on federal, state, and county lands.

Legend

A.C. = Allowable Cut

DR. = Drain

Softwood Hardwood

WEST HALF OF UPPER PENINSULA OF MICHIGAN

Background

The district is made up of eight counties and has a total land area of 5,571,000 acres, of which approximately 4,986,000, or almost 90 percent was classified as forest in 1936. Current surveys show 2 percent loss forest area or 4,880,000 acres.6/

The original forest was mainly northern hardwood with hemlock and pine in mixture. Sandy pine lands comparable to the Central Pine District of Minnesota occurred but were not extensive. Conglomerate mixtures of lowland hardwoods and conifers occupied poorly drained lands, amounting to about one-sixth of the total area, while black spruce, tamarack, and cedar covered the one-tenth of the land in bogs.

Second-growth northern hardwoods -- minus most of the pine and hemlock -- are the most extensive forests today. Aspen, commonly with an understory of northern hardwood or balsam fir, is second in area.

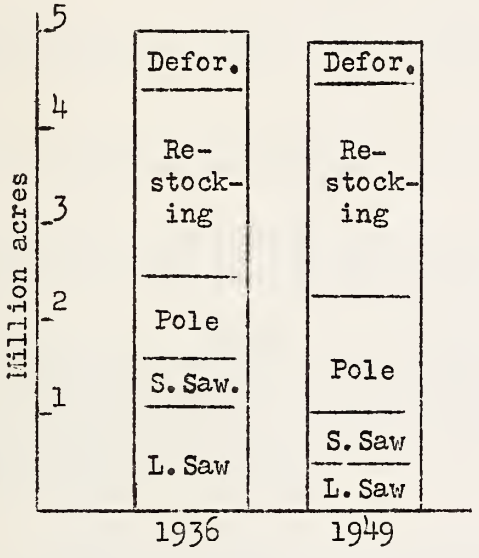
The district contains the Ottawa National Forest, Isle Royale National Park, the Porcupine Mountain State Park, and several lesser public areas. It has a variety of primary forest industries but relatively few secondary timber manufacturers. For a number of years it has been a major source of raw material for sawmills, veneer mills, pulp mills, and so forth, in Wisconsin and other parts of Michigan.

6/ Field work for new surveys has been completed in all counties, and type areas have been calculated for all lands outside of the national forest (preliminary estimates have been obtained for the national forest area). Volume and growth computations have been made on only five of the eight counties and growth on only four. Thus the figures presented here may be altered in some respects when final reports are prepared.

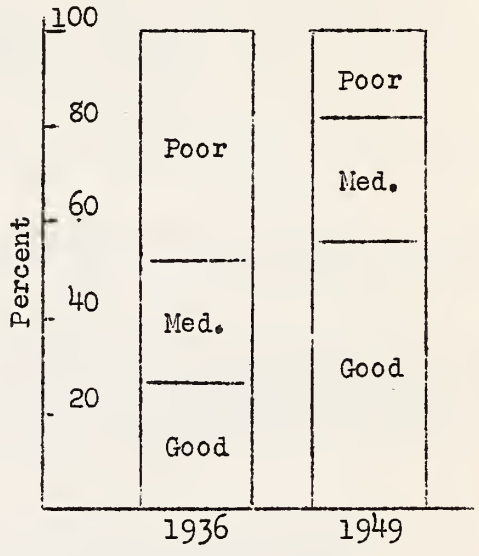
Outstanding changes in Forest Conditions, 1936-1949

Western Half of Upper Peninsula of Michigan

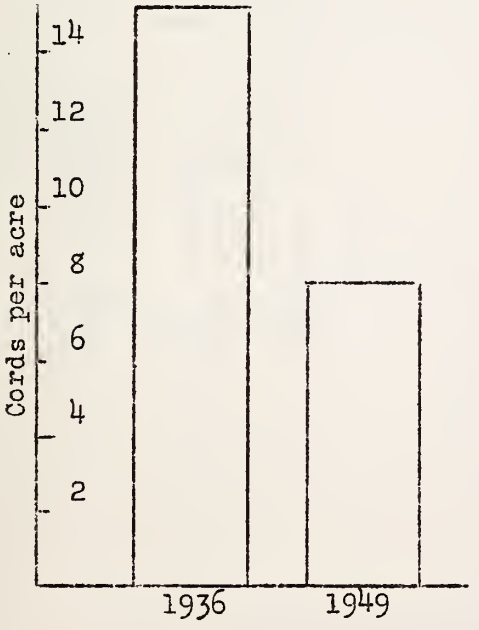
Stand-size class



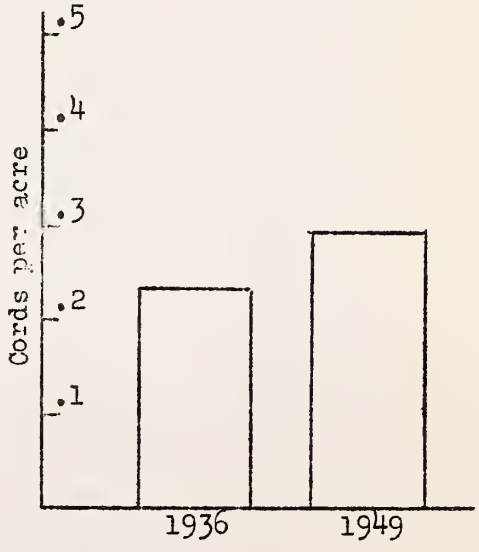
Density of stocking
(Seedling and sapling areas)



Average volume (on stocked area)



Average annual growth



Type Changes in the West Half of the Upper Peninsula

Acreage of softwood types has declined about 16 percent during the period between surveys, while that of hardwood types has gained (table 4).

Pine apparently has held its own, although the detailed figures suggest that jack pine has increased somewhat at the expense of white and red pine.

Spruce-balsam and swamp conifer types have lost 175,000 acres altogether. Presumably some of this has gone into a deforested classification (grass and brush) and some may have reverted to aspen after cutting.

The northern hardwood type has expanded to the extent of about 178,000 acres. Aspen has added 106,000 acres.

The deforested (grass and brush) acreage has shrunk very distinctly, a fact attributable partly to planting programs, but mainly to natural reforestation.

Total forest area appears to be 106,000 acres less than before. Some of this loss may be a result of a change in classification of woodland pasture. Any fenced woodlands less than 10-percent stocked with forest trees are now called nonforest, whereas formerly most of these woodlands were classified as nonstocked forest land.

Table 4.- Comparison of forest type acreages shown by two Forest Surveys - West Half, Upper Peninsula of Michigan

Forest type	Original survey	Current resurvey	Change
	Thousand acres		Percent
Pine	131	133	+ 1½
Spruce-balsam fir	512	395	-23
Swamp conifer	423	365	-14
All softwood	1,066	893	-16
Northern hardwoods	2,101	2,279	+ 8½
Ash-elm, etc. 1/	117	115	- 1½
Aspen-birch	1,084	1,190	+10
All hardwood	3,302	3,584	+ 8½
Grass and brush	604	375	-38
Noncommercial	14	28	+50
TOTAL FOREST	4,986	4,880	- 2

1/ Includes a very small acreage of oak.

Changes in Stand-Size Class

Probably the most significant change in the Upper Peninsula picture has been the 50+-percent reduction in area of large saw timber (shown in table 5). This clearly reflects the results of abnormally heavy logging during most of the period between surveys.

Another interesting point is the evidence of movement of stands from sapling into pole-timber size. This is especially notable in aspen, where pole-timber area increased 57 percent, and in the other hardwood types where it increased 63 percent.

In the hardwood types again there is evidence of movement from pole-timber to small saw-timber size. Small saw-timber area increased 37 percent between surveys. Some of this came from partially logged old-growth, but some unquestionably came as a result of growth.

Table 5.- Comparison of acreage by type group and size class, 1936-49
West Half, Upper Peninsula of Michigan

Forest types	Survey	Stand-size class				
		Saw timber		Pole timber	Seedlings and saplings	All 1/ classes
		Large	Small			
		Thousand acres				
Pine	Old	29	30	35	37	131
	New	14	27	33	59	133
Other softwood	Old	41	167	272	469	949
	New	4	72	293	391	760
Aspen-birch	Old	3	19	289	773	1,084
	New	1	33	454	702	1,190
Other hardwood	Old	1,020	287	256	655	2,218
	New	499	394	417	1,084	2,394
All types	Old	1,093	503	852	1,934	4,382
	New	518	526	1,197	2,236	4,477

1/ Excluding deforested and noncommercial area.

Changes in Density

Very encouraging evidence of improvement in younger timber stands is obtained from comparison of stand densities in the two surveys (table 6).

In pole-timber stands of all types, the proportion of poorly stocked stands has declined sharply. The shift has been least in the other softwood (spruce-fir and swamp conifer) types, due no doubt to heavy cutting for pulp on the one hand and relatively slow growth on the other. Even in these types, however, some improvement can be noticed.

In seedling and sapling stands, the evidence of "thickening" is very clear indeed. The presumption is that this has occurred as a result of improved fire protection, some planting, and more forest area under management. Because it is in very young stands, the improvement may not have any appreciable effect on timber yields in the immediate future, but it promises more for later periods.

Table 6.- Comparison of stand densities, 1936-1949, in pole-timber and seedling and sapling stands - West Half, Upper Peninsula of Michigan

Forest types	Density classification					
	Old survey			New survey		
	Good	Medium	Poor	Good	Medium	Poor
	Percentage					
POLE TIMBER STANDS						
Pine	9	23	68	15	40	45
Other softwood	16	29	55	11	46	43
Aspen	6	28	66	17	38	45
Other hardwood	9	22	69	16	35	49
All types	10	26	64	15	39	46
SEEDLING AND SAPLING STANDS						
Pine	8	16	76	32	24	44
Other softwood	27	23	50	31	32	37
Aspen	22	26	52	41	36	23
Other hardwood	35	25	40	76	18	6
All types	27	25	48	56	26	18

Changes in Timber Volume

Merchantable timber volume has declined 40 to 50 percent between surveys, despite the fact that per-acre volumes have increased in most of the younger stands. The decline is attributable mainly to liquidation of old-growth forests.

Although per-acre volumes have increased in practically all size classes of the softwoods, the over-all volume in pine types is about one-third less than before, and that in other softwood types about one-eighth less (table 7).

In most hardwood types, the heavy cutting plus changes in definition (elimination of 10-inch trees from saw timber and elimination of limbwood from total volume in the second survey) have resulted in drastic reduction in over-all volume. In the case of aspen, however, the over-all volume has practically doubled.

Changes in Annual Growth Rate

A preliminary growth estimate for the west half of the Upper Peninsula of Michigan shows about one-fourth greater growth than in 1936 in terms of total cubic volume. It averages .29 cords per stocked acre, compared with .23 cords previously. In terms of saw timber, present growth is one-sixth greater -- 52 board feet per stocked acre versus 45 board feet.

Softwood types are growing much more rapidly than previously estimated on a per-acre basis, but acreages have shrunk.

Hardwood types appear to be growing faster in cubic volume but, except for aspen, they have smaller board-foot growth per acre. The decline here may be due mainly to changed methods of measurement but probably reflects also some depreciation in average quality of stands.

Table 7.- Comparison of volume per acre by type groups and size classes, 1936-49 west half, Upper Peninsula of Michigan

SAW-TIMBER VOLUME PER ACRE - Board Feet

Forest type group	All stands		Large saw-timber stands		Small saw-timber stands		Pole-timber stands		Seedling and sapling stands	
	Old	New	Old	New	Old	New	Old	New	Old	New
Pine	3,230	2,200	9,400	9,700	3,800	5,300	950	820	80	190
Other softwoods	1,220	1,060	5,720	6,000	3,580	4,740	910	1,030	170	360
Aspen-birch	220	470	7,890	3,000	3,140	3,090	350	690	60	200
Other hardwoods	6,180	2,950	11,700	8,100	4,140	4,200	930	1,180	540	800
All types	3,540	1,950	11,380	8,100	3,900	4,200	730	950	250	520
TOTAL VOLUME PER ACRE - Cords										
Pine	10.8	9.5	32.8	29.6	13.7	15.5	6.0	9.8	0.8	1.8
Other softwoods	9.3	7.3	29.6	22.1	23.0	20.3	10.4	10.6	2.1	2.4
Aspen-birch	2.5	4.8	33.4	28.0	18.8	12.7	6.4	8.0	0.5	2.4
Other hardwoods	24.0	9.7	41.8	20.1	21.1	13.0	9.0	9.4	3.2	3.8
All types	15.1	8.0	41.0	20.5	21.4	14.1	8.5	9.2	1.8	3.1

Table 8.- Comparison of annual growth per acre by type groups and stand-size classes, 1936-49, west half, Upper Peninsula of Michigan

Forest type group	All stands		Saw-timber stands		Pole-timber stands		Seedling and sapling stands	
	Old	New	Old	New	Old	New	Old	New
SAW TIMBER - Board Feet								
Pine	73	114	107	206	75	160	15	24
Other softwoods	21	71	46	135	58	125	9	17
Aspen-birch	21	36	168	96	51	78	5	6
Other hardwoods	61	50	79	67	59	82	26	24
All types	45	52	77	78	57	93	13	17
TOTAL GROWTH - Cords								
Pine	.17	.39	.15	.50	.32	.48	.11	.26
Other softwoods	.14	.25	.06	.48	.18	.41	.14	.09
Aspen-birch	.28	.33	.29	.29	.58	.45	.18	.26
Other hardwood	.25	.27	.18	.21	.31	.40	.37	.28
All types	.23	.29	.17	.24	.36	.42	.23	.24

SUMMARY AND CONCLUSIONS

A comparison of figures from the original Forest Survey (1935-37) with those from recent resurveys in two Minnesota and Michigan districts gives some good clues concerning trends in Lake States forest conditions. Because the survey figures in both instances are based upon rather light samples, and because some of the figures from the resurvey are still tentative, firm conclusions cannot be drawn from the comparisons. However, indications are as follows:

1. Acreage of softwood types declined rather sharply during the 13-year period between surveys -- nearly 10 percent in the Minnesota Central Pine District and 16 percent in the western part of the Upper Peninsula of Michigan.

2. Deforested area shrunk in Michigan where northern hardwoods are the predominant natural cover. It increased in Minnesota where pine and swamp types are involved.

3. The acreage of aspen changed little in either district.

4. The area of large saw timber was reduced by half.

5. Density of stocking improved substantially, at least in seedling, sapling, and pole stands.

6. Forests now have a higher average volume per acre than before in four Minnesota counties tested. In Michigan, however, heavy liquidation of old-growth timber more than offset the improvement in smaller size classes, and resulted in a sharp decline in over-all volume.

7. Average annual growth per acre increased both in terms of board feet and total volume.

8. The allowable annual cut now is as large or larger than in 1936, but should include a larger proportion of hardwoods and should be obtained more generally from improvement cuttings and thinnings.

9. Current drain in the Minnesota district, while less than previously reported in terms of saw-timber material, is greater in terms of total volume. It is 64 percent greater than allowable cut in the case of softwood timber, but falls more than 50 percent short of allowable cut in hardwoods.

These indications seem to support the general conclusion that the period 1936-49 was a very destructive one as regards mature and merchantable timber, but at the same time one which permitted substantial improvement in condition of young growth. It saw some further deterioration in type

proportions (softwood versus hardwood) and in proportion of stand-size classes (merchantable versus young growth). But it saw improvement in stand densities and in current and prospective timber growth.

Fuller presentation of the new survey data, together with recommendations for remedial action are being published in a series of county reports -- in Minnesota by the Office of Iron Range Resources and Rehabilitation, St. Paul, and in Michigan by the Department of Conservation, Lansing. An analysis of the situation, state wide, will be published by the Lake States Station on completion of the resurveys in Minnesota and Michigan.

APPENDIX

Comparability of the Old and New Surveys

Without going into full details as to methods and specifications, it is necessary to call attention to certain points which have a bearing upon the validity of the comparisons between the original surveys and the resurveys. Although there are several differences between the surveys it is believed that the figures convey information of real significance and shed light on forestry trends which may be under way.

1. Both surveys were sampling propositions. The first followed a line plot system with 1/5-acre plots at 10-chain intervals on lines 10 miles apart. Each plot represented about 800 acres of land. The current survey is based upon nine 40-acre sample blocks per township. Each block represents 2,560 acres of land.1/ These sampling intensities provide area estimates with fairly small standard errors as regards total forest area, and of moderate magnitude for major types and condition classes where these are distributed over large districts such as those under consideration here. They do not provide a basis for hair-splitting comparisons of small types or conditions; for example, conditions covering less than 10,000 acres.

2. The Central Pine District in Minnesota as defined in the original survey did not exactly follow county lines. It has been necessary to make some minor adjustment, with the help of type maps, to make the data from current county-unit surveys correspond with the original district. No adjustments were needed in Michigan.

3. Work on the two surveys has been done by different crews which leads to possible differences in interpretation of type specifications. Some changes have also been made in definitions; for example, the minimum volume for saw-timber stands has been lowered from 2,000 board feet (1936) to 1,500 board feet (currently). Furthermore, no board-foot volume is figured in aspen or hardwood trees below 11 inches d.b.h. at present, whereas 9 inches was the minimum diameter originally. On the other hand, because of improved markets, fewer trees are classified as culls and fewer areas are called noncommercial now than in 1936. Hardwood limbs were included in the original cubic-volume estimate but are excluded in the resurveys.

4. In the original survey, type proportions were based entirely upon interpretation of types on small sample plots, whereas current figures come from mapping. The former method leads to type purification while the latter encourages some generalization of condition classes.

1/ The present survey also incorporates national forest area data based upon 100-percent mapping on areas within national forest boundaries.